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2

91164M

911645

Tuhia he (☒) ki te pouaka mēnā kāore koe i tuhi kōrero ki tēnei puka

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Te Mātai Matū, Kaupae 2, 2024

91164M Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao

Ngā whiwhinga: E rima

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao.	Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao, kia hōhonu.	Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao, kia tōtōpū.

Tirohia kia kitea ai e rite ana te Tau Ākonga ā-Motu (NSN) kei runga i tō puka whakauru ki te tau kei runga i tēnei whārangi.

Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.

He taka pūmotu, he rauemi anō hoki hei toro māu kua whakaurua ki te Pukapuka Rauemi L2–CHEMMR.

Ki te hiahia wāhi atu anō koe mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka.

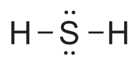
Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2–23 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ana te kauruku whakahāngai (⁄⁄⁄). Ka poroa taua wāhi ka mākahia ana te pukapuka.

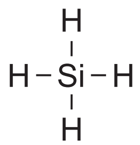
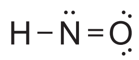
HOATU TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

TE TŪMAHI TUATAHI

(a) Tāngia te hoahoa irahiko (Lewis structure) mō ngā rāpoi ngota e rua e takoto kau ana, ka whakaingoa ai i ō rāua āhua.

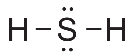
Te rāpoi ngota	**NI_3** (hauota kahautawa-toru – nitrogen triiodide)	**H_2S** (hauwai pungatara – hydrogen sulfide)	**CS_2** (waro pungatararua – carbon disulfide)
Te hoahoa irahiko			
Te ingoa o te āhua		e piko ana	
Te takiwā o te koki honohono huri noa i te ngota pū	109.5°	109.5°	180°

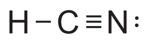
(b) Whakatauritea, whakatauarotia hoki ngā āhua me ngā koki honohono o te takawai hauwai-whā (silicon tetrahydride), SiH_4, me te hauota ōkai-iti (azanone), HNO.

Te rāpoi ngota	**SIH_4** takawai hauwai-whā	**HNO** hauota ōkai-iti
Te hoahoa irahiko		

(c) He rerekē te āhua o ngā rāpoi ngota hauwai pungatara (hydrogen sulfide), o te H_2S, i te hauwai tāoke (hydrogen cyanide), i te HCN, engari e ōrite ana te tōranga.

E whakaaturia ana te hoahoa irahiko o ēnei rāpoi ngota e rua ki raro iho nei:

hauwai pungatara 

hauwai tāoke 

(i) Porohitatia te kupu kei raro iho nei e tautuhi ana i te tōranga o te H_2S me te HCN.

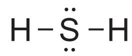
Tōranga **Tōranga-kore**

(ii) Parahautia tō kōwhiringa tōranga:

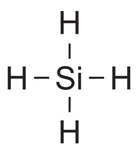
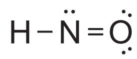
- mā te whakamārama i ngā hononga i waenganui i ngā honohono me ngā hanga o ia matū,
- me te whakahāngai i tēnei ki te whakataunga o te tōranga o tētahi rāpoi ngota.

QUESTION ONE

(a) Draw the Lewis structure for each of the two blank molecules, and name their shapes.

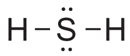
Molecule	**NI_3** (nitrogen triiodide)	**H_2S** (hydrogen sulfide)	**CS_2** (carbon disulfide)
Lewis structure			
Name of shape		bent	
Approximate bond angle around central atom	109.5°	109.5°	180°

(b) Compare and contrast the shapes and bond angles of silicon tetrahydride, SiH_4, and azanone, HNO.

Molecule	**SIH_4** (silicon tetrahydride)	**HNO** (azanone)
Lewis structure		

(c) Hydrogen sulfide, H_2S, and hydrogen cyanide, HCN, molecules have a different shape, but they both have the same polarity.

The Lewis structure of both of these molecules are shown below:

hydrogen sulfide 

hydrogen cyanide 

(i) Circle the word below which identifies the polarity of both H_2S and HCN.

Polar **Non-polar**

(ii) Justify your choice of polarity by:

- explaining the links between the bonding and structure of each substance, and
- relating this to how the polarity of a molecule is determined.

(d) Ka whakamahia whānuitia te rongoā patu poke aramimi (Methanamine), te CH_3NH_2, hei whakaputa i ngā rongoā, i ngā patu hekaheka, i ngā patu pepeke, i ngā kū horoi, i te ahumahi papanga hoki.

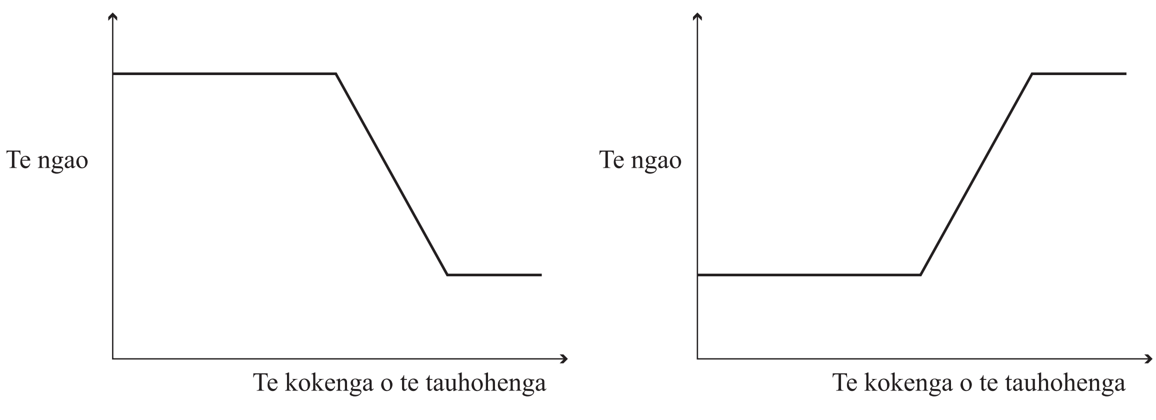
Ahakoa he tino paitini te hauwai tāoke, te HCN, ka taea te whakamahi hei whakaputa rongoā patu poke aramimi, e whakaaturia ana i te tauhohe ki raro iho nei.

$$HCN(g) + 2H_2(g) \rightarrow CH_3NH_2(g) \quad \Delta_r H = -158 \text{ kJ mol}^{-1}$$

(i) Tātaihia te papatipu o te rongoā patu poke aramimi ka puta ina tukuna te 1890 kJ o te ngao.

$M(CH_3NH_2) = 31.0 \text{ g mol}^{-1}$

(ii) Kōwhiria te hoahoa ngao e tika ana, e whakaata ana i te tauhohe o runga, ka mutu, tapaina ki ngā taipitopito i tukuna i te whārite.



(d) Methanamine, CH_3NH_2, is used widely in the production of pharmaceuticals, fungicides, insecticides, cleaning agents, and in the fabric industry.

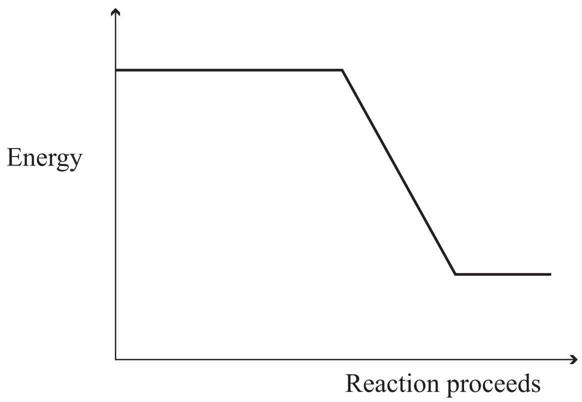
Although hydrogen cyanide, HCN, is highly poisonous, it can be used to produce methanamine, as shown in the reaction below.

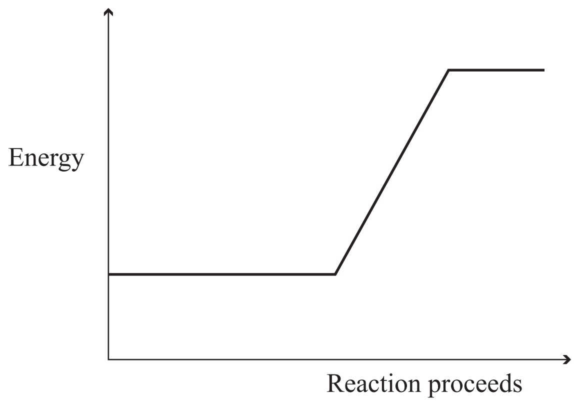
$$HCN(g) + 2H_2(g) \rightarrow CH_3NH_2(g) \quad \Delta_r H = -158 \text{ kJ mol}^{-1}$$

(i) Calculate the mass of methanamine formed when 1890 kJ of energy is released.

$M(CH_3NH_2) = 31.0 \text{ g mol}^{-1}$

(ii) Choose the correct energy diagram that represents the reaction above and label it with the information provided in the equation.





TE TŪMAHI TUARUA

(a) Whakaotingia te tūtohi o raro iho nei mō ia matū e totoka ana.

Te totoka	Te pae rewa (°C)	Te momo totoka	Te momo korakora	Ngā tōpana pipiri i waenga i ngā korakora
$SiO_2(s)$ (takawai hāora-rua)	1700			
$SiCl_4(s)$ (takawai pūhaumāota-toru)	–69			
$CuCl_2(s)$ (konukura (II) pūhaumāota)	620			
$Al(s)$ (konumohe)	660			

(b) He takawai tō te SiO_2 me te $SiCl_4$, engari he tino iti iho te pae rewa o te $SiCl_4$.

Whakamāramatia te take e rerekē nei te pae rewa o ēnei matū.

QUESTION TWO

(a) Complete the table below for each substance in their solid state.

Solid	Melting point (°C)	Type of solid	Type of particle	Attractive forces between particles
SiO_2(*s*) (silicon dioxide)	1700			
$SiCl_4$(*s*) (silicon tetrachloride)	–69			
$CuCl_2$(*s*) (copper (II) chloride)	620			
Al(*s*) (aluminium)	660			

(b) Both SiO_2 and $SiCl_4$ contain silicon, but $SiCl_4$ has a considerably lower melting point.

Explain why there is a difference in melting point for these substances.

(c) Whakamāramatia te take kāore te takawai pūhaumāota-toru, te $SiCl_4$, e memeha i te wai, engari ka memeha te konukura(II) pūhaumāota, te $CuCl_2$.

I tō tuhinga:

- me kōrero ngā hanga me ngā hononga
- me whakauru te momo tāmeha e memeha ai te $SiCl_4$ me te take ka pērā
- me whakauru tētahi hoahoa hei tautoko i tō tuhinga mō te $CuCl_2$.

He hoahoa hei whakaatu i te $CuCl_2$ e memeha ana i te wai.

(c) Explain why silicon tetrachloride, $SiCl_4$, does not dissolve in water, but copper(II) chloride, $CuCl_2$, does.

In your answer:

- link to their structure and bonding
- include the type of solvent that $SiCl_4$ will dissolve in, and why
- include a diagram to support your answer for $CuCl_2$.

Diagram to show $CuCl_2$ dissolving in water.

TE TŪMAHI TUATORU

E 60% te nui o te powaro, o te C_3H_8, e 40% hoki te nui o te pūwaro, o te C_4H_{10}, i ngā puoto kapuni ka tukuna ki Aotearoa.

Kei raro iho nei te tauhohe ngingiha o te kora powaro me te kora pūwaro.

(a) Whakaaturia mai, mā te tātai, te nui ake o te ngao ka puta i ia 1.00 kg o te powaro, tēnā i te 1.00 kg o te pūwaro.

(i) Te ngao ka tukuna i te ngingiha o te 1.00 kg o te powaro

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g) \qquad \Delta_rH = -2044 \text{ kJ mol}^{-1}$$

$$M(C_3H_8) = 44.1 \text{ g mol}^{-1}$$

(ii) Te ngao ka tukuna i te ngingiha o te 1.00 kg o te pūwaro

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g) \qquad \Delta_rH = -2877 \text{ kJ mol}^{-1}$$

$$M(C_4H_{10}) = 58.1 \text{ g mol}^{-1}$$

(iii) Tātaihia te nui ake o te ngao ka tukuna i te 1.00 kg o te powaro, tēnā i te 1.00 kg o te pūwaro.

QUESTION THREE

Bottled gas supply in New Zealand is a 60% propane, C_3H_8, and 40% butane, C_4H_{10}, mix.

The combustion reactions for both propane and butane fuels are given below.

(a) Show by calculation how much more energy is released per 1.00 kg of propane compared to 1.00 kg of butane.

(i) Energy released by 1.00 kg of propane combustion

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g) \qquad \Delta_r H = -2044 \text{ kJ mol}^{-1}$$

$$M(C_3H_8) = 44.1 \text{ g mol}^{-1}$$

(ii) Energy released by 1.00 kg of butane combustion

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g) \qquad \Delta_r H = -2877 \text{ kJ mol}^{-1}$$

$$M(C_4H_{10}) = 58.1 \text{ g mol}^{-1}$$

(iii) Calculate how much more energy is released by 1.00 kg of propane than 1.00 kg of butane.

(b) E whakaaturia ana te tohenga o tētahi pūkora hauwai ki raro iho nei. Ka tauhohe te hauwai ki te hāora e hua mai ai te wai.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g) \qquad \Delta_r H = -484 \text{ kJ mol}^{-1}$$

H–H	O=O	H–O–H
H_2	O_2	H_2O

Whakamahia ngā ngao honohono kua whakarārangihia i te tūtohi, me te panonitanga o te hāwera (–484 kJ mol^{-1}) i tukuna mō te tauhohenga, hei tātai i te toharite ā-ngao honohono o te hononga O–H.

Te hononga	**Te ngao honohono (kJ mol^{-1})**
H–H	436
O=O	498

E rere tonu ana te Tūmahi Tuatoru i te whārangi e whai ake nei.

(b) The reaction of a hydrogen fuel cell is shown below. Hydrogen reacts with oxygen to produce water.

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta_r H = -484$ kJ mol^{-1}

H–H	O=O	H–O–H
H_2	O_2	H_2O

Use the bond energies listed in the table, and the change in enthalpy (–484 kJ mol^{-1}) provided for the reaction, to calculate the average bond energy of the O–H bond.

Bond	**Bond energy (kJ mol^{-1})**
H–H	436
O=O	498

Question Three continues on the next page.

(c) He momo waro hou te 'Galvorn' i waihangatia ai, e kaha ana, e taimāmā ana, e pai ana hoki hei kawenga hiko. He tautaiao nō tōna tukanga whakanao, me te whānui hoki o ana whakamahinga, e whakapaetia ana ka taea pea e te Galvorn te whakaiti te whakawhirinakitanga ki ngā konganuku whānui ka whakaputaina i runga i te kaha o te whakapau ngao.

(i) He pūkawe hiko te Galvorn, pērā i te matāpango.

Me whai aha te Galvorn e pai ai tana kawe i te hiko?

(ii) He pai hoki te konumohe, te Al, hei kawe hiko, ka mutu, he māngohe hoki (ka taea te ahuahu kia puta ōna momo āhua). Nā ēnei āhuatanga, ka taea te kaha whakamahi te konumohe i ngā waea hiko o runga, i ngā waehanga me ngā anga i ngā waea atamai me ngā rorohiko pōnaho.

Whakamāramatia te take kei te konumohe, kei te Al, ēnei āhuatanga, ka mutu, tūhonoa ki ngā whakamahinga kua kōrerohia.

Me kōrero tōna hanga me tōna honohono.

He pūkawe hiko:

He māngohe:

(c) ‘Galvorn’ is a newly developed form of carbon that is strong, light, and has good conductivity. With its clean manufacturing process and wide range of applications, it is anticipated that Galvorn could reduce the reliance on standard metals that are energy intensive to produce.

(i) As with graphite, Galvorn conducts electricity.

What requirement must Galvorn have to allow it to conduct electricity?

(ii) Aluminium, Al, is also a good conductor of electricity, and it is malleable (can be pressed into shapes). These properties enable it to be used extensively in overhead power lines and for components and shells in smartphones and laptops.

Explain why aluminium, Al, has these properties, and link it to the uses stated.

Refer to its structure and bonding.

Conducts electricity:

Malleable:

He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

English translation of the wording on the front cover

91164M

Level 2 Chemistry 2024

91164M Demonstrate understanding of bonding, structure, properties and energy changes

Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of bonding, structure, properties and energy changes.	Demonstrate in-depth understanding of bonding, structure, properties and energy changes.	Demonstrate comprehensive understanding of bonding, structure, properties and energy changes.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table and other reference material are provided in the Resource Booklet L2–CHEMMR.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–23 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.